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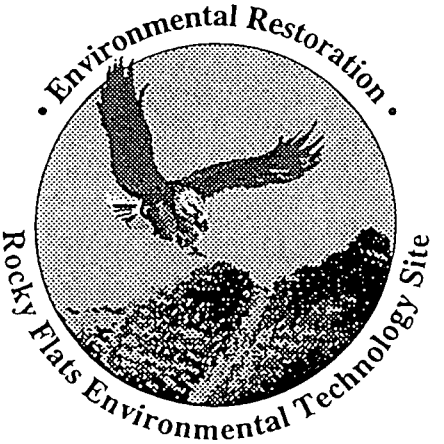
CANBERRA IN SITU SERVICES

ISOCS GAMMA SPECTROSCOPY SYSTEM INPUT PARAMETER

RF/RMRS-98-262



September 1, 1998
Revision 0

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ISOCS GAMMA SPECTROSCOPY SYSTEM INPUT PARAMETER

Rocky Mountain Remediation Services, L.L.C.

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ADMINISTRATIVE INFORMATION

Site: Rocky Flats Environmental Technology Site (RFETS), Golden, Colorado

Project Name: Site Characterization of the 903 Drum Storage Area (IHSS 112), 903 Lip Area, (IHSS 155), and Americium Zone

Date Prepared: September 1, 1998

Approvals

I have read and concur for release of this procedure with respect to the hazards, regulatory requirements and objectives of the project.

L 2 Boothy — 9/3/98

Name — Date
Canberra Project Manager

Gregg D Gregson — 9/3/98

Name — Date
RMRS Quality Assurance Representative

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Name — Date
RMRS Contract Technical Representative/Project Manager

[signature] — 9/3/98

Name — Date
RMRS Radiological Engineering

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APPENDIX

1.0 PURPOSE

This procedure describes the steps necessary for ISOCS generated calibrations of the Canberra Mobile In Situ Services ISOCS system.

2.0 SCOPE

This procedure is applicable for use by all Canberra Industries CI and/or subcontract personnel when performing ISOCS calibrations. The CI ISOCS system is calibrated with the ISOCS calibration program to provide accurate analysis results for a variety of activity distributions in soil at or near the ground surface, pipes, boxes, tanks, etc.

3.0 PROCEDURE

3.1 Before You Start

3.1.1 Determination of all physical data needed to model the soil plane using the ISOCS circular plane template. This includes determining the critical outer dimensions of the circular plane, as well as the chemical composition and density of the soil matrix. This will be accomplished with previously measured samples and NIST Rocky Flats Reference Material.

3.1.2 After choosing the circular plane ISOCS template, determine the effective physical dimension of the plane using a point source. Alternatively, the effective field of view can also be determined by running ISOCS efficiencies.

NOTE: The ISOCS circular plane template contains five positioning parameters, which specifies the position of the detector relative to a reference point on the ground. This reference point will be established by global positioning and an imaginary line drawn vertical will pass through the center of the detector. Therefore, for in situ gamma measurements only one of these five dimensions is critical, which is the distance from the face of the detector to the reference point on the ground.

3.1.3 Determine the chemical composition and density of the soil matrix. Evaluate previous reports and measurements for these parameters provided by RMRS. All references and assumptions concerning these measurements will be reported to and accepted by RMRS prior to any measurements being taken.

3.1.4 The uncertainty associated with these parameters will be evaluated and will be used to calculate an uncertainty for the efficiency calculation. This uncertainty in turn will be included as part of the total propagated uncertainty.

3.1.5 Specify the assumed activity distribution within the sample matrix. The data table for the circular plane template includes a column labeled "SOURCE CONCENTRATION." This data field is used to specify the relative distribution in the soil, which is present in each section or layer of the object. Previous measurements will be utilized within the project area to establish this distribution. The distribution utilized for this project will be verified with actual measurements. All assumptions, references and verifications will be reported to and approved by RMRS prior to reporting of data.

3.2 INPUT PARAMETERS TO DETERMINE GAMMA DETECTOR EFFICIENCIES

3.2.1 After obtaining, all of the physical data needed to define the current measurement configuration, the ISOCS Calibration Software is used to input the necessary parameter values. This process must be completed before ISOCS efficiencies can be determined.

3.2.2 Start the ISOCS Calibration Software by accessing the WIN95 desktop screen and double click on the ISOCS icon. When ISOCS is started, the main user interface menu will appear, filling the entire display screen.

At the top of this screen is a menu bar with four options: File, Template List, Parameter Input, and Equipment. Near the bottom of this screen is a status table which shows the specific detector, collimator and template name selected for efficiency calculation, various Help messages, and the current default units for parameter input.

3.2.3 To begin, the parameter input process use the left/right arrow keys to change the focus in the menu bar to the **Equipment** option, then Press **ENTER**. The Equipment menu will be displayed with the Detector option highlighted.

3.2.4 Press ENTER to accept the highlighted Detector option. This will display a submenu that will list of all previously characterized detectors which can be selected for ISOCS efficiency calibrations.

3.2.5 Use the up/down arrow keys, if necessary, to highlight the desired entry in the Detector submenu, then Press ENTER. At this point, the Equipment menu will be re-displayed and the selected detector name will appear in the DETECTOR column of the status table.

3.2.6 If shielding components are used to restrict the detector field of view during sample count acquisitions, it is necessary to specify the dimensions and composition of these components to ensure accurate efficiency calculations. This is done by using the down arrow key to highlight the Collimator option in the Equipment menu, then Pressing ENTER.

3.2.7 Selecting this option will display a submenu, which lists all previously defined shield/collimator configurations. Entries will be listed for the standard ISOXSHLD Shield configurations. Special for input of all new parameters, and None to blank put all previous parameter values.

3.2.8 Use the up/down arrow keys to highlight/select the circular plane template, as shown in Appendix A of this procedure. The circular plane template will be shown in the status table, and the focus will move to the File menu.

3.2.9 Use the left/right arrow keys to change the focus in the menu bar to the Template list option. The Template List menu will be displayed with the first name in the list highlighted.

3.2.10 Use the up/down arrow keys to highlight/select the circular plane template, as shown in Appendix A of this procedure. The circular plane template will be shown in the status table, and the focus will move to the **File** menu.

3.2.11 If a change to the collimator dimensions is necessary, then the Collimator Dimensions option is used to enter, modify and/or view the parameter values, which define a specific set of shield/collimator components. To change the Collimator Dimensions use the left/right arrow keys to change the focus to the Parameter input menu. Use the arrow keys to highlight the Collimator Dimensions submenu, then Press ENTER. A table of previously entered parameter values will be displayed.

If the Collimator submenu was not used to select a previous set of parameter values, the COLLIMATOR field and all collimator data table fields will be blank. The Description and Comment fields can be used to input any desired text string. The 11 fields in the DIMENSIONS section can be modified if necessary using the backspace, period (.), number, arrow, Esc and other specific keys as previously described for the template data table fields.

Press F2 to see the graphical portion of the COLLIMATOR drawing, Press Esc to return. Enter the proper value of CRPN (Collimator Reference Point Number).

3.2.12 To ensure that the dimension units for the ISOCS calibration are the same as the units measured for the calibration object, use the left/right arrow keys to change the focus to the Parameter input menu. The default units for LENGTH, TEMP (air temperature), DENSITY, RH (relative humidity), and PRESS (barometric pressure) are: cm, degrees Celsius, grams per

cubic centimeter, percent relative humidity, and mm Hg, respectively. These units are shown in the Dimensions field of the Collimator Parameters Table, and are appropriate for most ISOCS measurements. Use the Dimension Units option to modify the default units for LENGTH, TEMP (air temperature), DENSITY, RH (relative humidity) and PRESS (barometric pressure), if desired. Selecting this option will display the *Dimension Units submenu.*

To change one of these units, use the arrow keys to highlight the desired field in the Dimension Units submenu, then Press ENTER. The field for the new unit will then be highlighted in green instead of white. Repeat this process for other units, if desired. Press Esc to accept the changes and return to the Parameter input menu. The fields in the status table will be updated with the new units.

CAUTION: If one or more of the default units are changed, any previously entered source dimension values, collimator dimension values, and air parameter values will automatically be converted to the new units.

3.2.13 Use the Air Parameters option in the Parameter Input menu, if necessary to change the default values for TEMP (air temperature), RH (relative humidity), and PRESS (barometric pressure). The default values used by the ISOCS software are: 20 degrees Celsius, 50% RH, and 760 mm Hg, respectively. These values are appropriate for most ISOCS measurements. However, as the object-to-detector distance increases, the effects of photon absorption in air become significant at low energies, and more accurate values for these parameters should be entered.

3.2.14 Use the **Library Materials Edit** option in the **Parameter Input** menu, if necessary to edit, add, or deleted material definitions. Any currently open parameter data flow must first be saved or canceled before proceeding with this operation. If no data flow is open, selecting **Library Materials Edit** from the Parameter input menu will display a table of previously defined materials.

The first entry in the upper left corner of the Material Selection Table will be highlighted. The text string directly below this table shows the composition of the highlighted material. The chemical formula used to define each material must follow specific syntax rules, which are discussed later in this section. To return to the Parameter input menu at this point, Press Esc.

To delete an entry from the Material Selection Table, use the arrow keys to highlight the desired material name. The Page Up and Page Down keys can also be used if more than 23 material names have been entered. Press ENTER to continue the deletion process. The selected material name will be highlighted in green instead of white, and a confirmation message will be displayed. Press Y to delete the highlighted material, or

Press Esc to abort the deletion process and retain the highlighted material name.

The Material Selection Table can also be used to add a new material name to the library file. As noted in the HELP STRING message field, pressing Alt+N [for New] will initiate this process. (The notation Alt+N indicates that the N key is to be pressed while holding down the Alt key.) After pressing Alt+N, a prompt for entry of a chemical formula will be displayed. The line directly below the "USE ONLY THE... SYMBOLS" message is used to input the appropriate formula.
The (_) key, plus (+) key, period (.) key, number keys, and letter keys (displayed in uppercase only) are used to input the chemical formula. The backspace key can be used to clear unwanted characters. The following examples demonstrate the syntax requirements when entering a chemical formula (where WATER and SACID are existing names in the Material Selection Table which correspond to previously defined materials):

- 100SI_O2 or SI_O2 denotes [100% SiO_2]
- 82H2_O+18NA2_S_O3 denotes [82% H_2O + 18% Na_2SO_3]
- 50WATER+50NA2_S_O3 denotes [50% WATER + 50% Na_2SO_3]
- 2.5SACID+97.5WATER denotes [2.5% SACID + 97.5% WATER]

The standard one-letter or two-letter chemical symbols are used to specify individual elements. An integer following an element name indicates the relative number of atoms of that element in each component; 1 is assumed if no value is specified. The numbers preceding each component are percent weight values (100% is assumed if no value is specified). The percent values of all individual components combined using the plus (+) key must add up to 100%. Any number of components can be combined in a single chemical formula.

To terminate input of the chemical formula, **Press ENTER**. The entered formula will then be tested for proper syntax. Ambiguous portions of the formula will be truncated and the remaining portion redisplayed for modification. If no errors are encountered upon terminating the formula input, a prompt for entry of a material name will be displayed. Pressing Esc at this point will return you to the Material Selection Table.

For example, consider the following sequence of steps:
Enter SI_O2 as the chemical formula, **Press ENTER**. Next, enter SAND in response to the "GIVE THE MATERIAL NAME..." prompt. The screen shown in Figure 3.18 of the ISOCS manual will be display.

Each material name is limited to eight characters or less and should normally include only alphabetic characters. Individual chemical element names (e.g., H or NA) cannot be used as material names, to avoid ambiguity in chemical formula interpretation.

Numbers can be included as part of the material name if desired. However, if numbers are used as the first character(s) in a material name, that material cannot be used with the plus (+) key as part of a new chemical formula. For example, 5WETSAND could be entered as the material name, and used for the formula 5WATER+95SAND; however, the material name 5WETSAND could not then be combined with other components in a new chemical formula.

After entering an appropriate material name (e.g., SAND here), Press ENTER to continue. If the entered name already appears in the Material Selection Table, a message will be displayed stating "THIS NAME ALREADY EXISTS. MODIFY OLD DATA? [Y/N]." Press Y to overwrite the old chemical formula, or Press Esc to abort the material definition process and return to the Material Selection Table.

If the format of the new material name is acceptable, the name will be added to a field in the Material Selection Table. At this point, press Alt+N to define another material, or **Press Esc** to return to the **Parameter Input** menu.

3.2.15 Use the **Energies & Convergence** option to modify the CONVERGENCE, ENERGY and ERROR parameter values used in the efficiency calculation process. The default values for ENERGY, ERROR and CONVERGENCE are specified in a file named DEFAULT.ENR in the ISOCS\AUX_FILE\TAB_DESC directory. New default values may be specified by editing this file.

Instead of editing the DEFAULT.ENR file, new values for the CONVERGENCE, ENERGY and ERROR parameters can be specified for temporary use by selecting **Energies & Convergence** from the **Parameter input** menu. This will display a submenu.

Use the arrow keys to highlight the desired field, then enter the new parameter value. Press Esc to accept the changes and return to the Parameter input menu. Any changes made using this menu option will remain in effect until the **Exit** operation is completed. The maximum recommended value for CONVERGENCE is 1.0%. Lower values may be specified, but this will increase the time required to perform the efficiency calculation. The ISOCS computed efficiency is an iterative process. The convergence value is used to determine when the process is complete.

Approximately ten values ranging from 50 keV to 3000 keV will be used. The default energy values and corresponding errors for most ISOCS systems are shown in the Energies & Convergence submenu. These values are appropriate for most ISOCS measurement applications.

The ERROR value is the estimated efficiency uncertainty value for that energy. It is currently a user-input value from DEFAULT.ENR. It is used by Genie PC as part of the efficiency fitting program and a part of the error propagation process for the final sample analysis error. A non-zero value must be entered.

3.2.16 Select the **Source Dimensions** option from the **Parameter Input** menu to display a data table for the selected template.

3.2.17 The dimensions corresponding to each data field in columns d.1 - d.5 are shown in the template drawing.

3.2.18 To display this drawing, use the up/down arrow keys to highlight the Current Template View option in the **Parameter input** menu, then **Press ENTER**. This will display the current selected template drawing. The plus (+), minus (–), Page Up, Page Down, and arrow keys can be used to expand and view different portions of this template drawing. **Press Esc** to return to the Parameter input menu.

3.2.19 Enter all parameter values needed to define the container and/or sample matrix, and to specify the position of the detector relative to the soil plane.

3.2.20 Each entry made in the Material column must match a specific name and chemical formula present in the ISOCS material library file.

3.2.21 The last column in these tables is used to specify the assumed activity distribution within the sample matrix.

3.2.22 Store the current set of parameter values on disk by selecting the Save option from the File menu. This will create a file, which can be retrieved using the Load option and modified to characterize similar objects, if necessary.

When the parameter-input process is complete, the current data flow may be used to generate an ISOCS efficiency calibration file, as detailed in section 3.3 of this procedure.

3.3 ISOCS EFFICIENCY CALIBRATION

3.3.1 With the File menu displayed, use the up/down arrow keys to highlight Calc+Save, Calc+Clear, or Calc+Add option, then Press ENTER.

NOTE: The Calc+selections will perform the following functions:

3.3.1.1 Calc+Save is one of three options listed under the Calculate heading in the **File** menu. This option combines the steps of performing an efficiency calculation and saving the current set of template parameters. This provides a convenient alternative to selecting **Save** and **Calc+Clear** as separate operations.

3.3.1.2 The **Calc+Clear** option is used to clear any previous efficiency data and perform a new ISOCS efficiency calculation. Efficiency values will be computed for a default set of energy values between 50 keV and 7000 keV. These results will then be used to create and save an ISOCS efficiency calibration file in the GENIE2K\CALFILES directory.

The default energy values used for efficiency calculations are specified in a file named DEFAULT.ENR in the ISOCS\AUX_FILE\TAB_DESC directory. These energy values may be changed by editing this file, if desired. The default values initially specified by Canberra will be utilized for this project and are: 50, 60, 75, 100, 200, 300, 500, 1000, 2000, and 3000 keV.

Proper execution of the **Calc+Clear** operation requires that the following three conditions be satisfied:

1. The **Template list** menu must be used to select the desired template type (i.e. CIRCULAR PLANE).

2. All parameters needed to adequately populate the selected template must be entered by using the **Load** and/or **Source Dimensions** options.

3. A specific detector must be selected by using the **Detector** submenu. Collimator parameters may also be specified if desired, but this is not required.

The conditions specified above are the same as those required for proper execution of the Save operation. When these conditions are satisfied, selecting the Calc+Clear option from the File menu will display a table with three fields (FILENAME, DESCRIPTION, and COMMENTS).

If the current parameter values were entered without using the Load option, the FILENAME and DESCRIPTION fields will be blank. An entry is required for the FILENAME field, and optional (but recommended) for the DESCRIPTION and COMMENTS fields. If the current data flow was initiated by loading a previously stored file, these fields will contain entries from the old file. Use the left/right arrow keys to highlight each field and enter appropriate new text, if desired.

When needed, the efficiency calculation can be aborted by pressing **Esc**. To continue the calculation with the current data flow and FILENAME field entry, **Press ENTER**. Unlike the **Save** and **Calc+Save** options, the **Calc+Clear** operation will not save the current template parameters or overwrite an old template file. The entry in the FILENAME field can, however, be reused to overwrite a previous efficiency calibration file in the GENIE2K\CALFILES directory.

When the **Calc+Clear** operation continues, the current data flow is checked for deficiencies and inconsistencies. If problems are detected, this operation will be interrupted and a list of error/warning messages will be displayed. If all messages cannot be displayed on a single screen, press Page Up and Page Down to scroll the message list. Press Esc to exit the message list screen.

If only non-fatal warning messages were displayed, the **Calc+Clear** operation can either be resumed by pressing Y, or aborted by pressing Esc, as stated in the HELP STRING field of the status table. If a fatal error was encountered, this operation will be aborted automatically. Correct all errors in the current data flow before re-selecting the Calc+Clear option. When the **Calc+Clear** operation proceeds without errors, an elapsed time and estimated completion time screen will be displayed. This screen includes values, which are updated periodically as the calculation progresses. When the calculation is complete, the File menu will be displayed. The **EXIT** option should then be selected to create the efficiency calibration file.

3.3.1.3 **Calc+Add** is the last of three options listed under the Calculate heading in the File menu. This option is used to sum the efficiency values from multiple calculation operations. Efficiency values calculated during the first execution of this option are not cleared prior to each successive Calc+Add operation. This allows a composite efficiency calibration file to be created for a single detector moved to different positions, or for multiple detectors viewing the same object.

Successful execution of this operation requires that the same preconditions be satisfied as previously specified for the **Calc+Clear** option. As an additional restriction, the **Energies & Convergence** option cannot be used to change the listed energy values or the Convergence parameter value between successive **Calc+Add** operations. This is to ensure that the efficiency summing process is performed in a consistent manner for all energies. As with the other two Calculate options, the **EXIT** option should be selected to complete the creation of the final efficiency calibration file.

3.3.2 After selecting **EXIT** in the above step the completion of the ISOCS calibration process will begin with a message, stating "Data flow is OPENED" will be displayed, with the Save Data response field highlighted.

3.3.3 After saving or canceling the current data flow, the **EXIT** operation will proceed in one of two ways. If one of the Calculate operations has not been performed, a message window shown stating that ISOCS file was not created. **Press ENTER** or A to exit ISOCS. If one of the Calculate operations has been successfully performed, a different series of messages will be displayed, the first of which is "Do you want Efficiency or Efficiency*Source Mass to be stored in a CAM file?"

3.3.4 Efficiency*Mass is the appropriate response since the final analysis results are to be reported in activity concentration units (e.g., Bq/kg or pCi/g). Activate the **Efficiency*Mass** button.

3.3.5 A dialog box window will then be displayed requesting the Destination file name to specify the final efficiency calibration file. The previous FILENAME entry, specified using the File Name field that appears when the Save option is invoked, will appear in this field. A new file name with up to eight alphanumeric characters can be entered in the Destination field.

The recommended naming convention for the CIRCULAR PLANE is CIRPLAnn. Where nn is a sequential integer starting at 01, corresponding to a specific set of template, detector, and collimator parameters.

3.3.6 If the entered name does not match that of a previously stored efficiency calibration file, a new file will be stored and the **EXIT** operation will be completed. The new file will be stored in the GENIE2K\CALFILES directory, with the .**CAL** extension added to the file name. If the entered name matches that of a previously stored efficiency calibration file, the window will be displayed with the message that the file already exists. At this point you have the option to **Overwrite** the old file and complete the **EXIT** operation, or **Enter New** a new calibration file name by returning to the Calibration File Name window.

3.3.7 After selecting the Efficiency response, two additional messages will be displayed: "Please Wait... Creating CAM File," followed by "Loading CAM file for display..." At this point, a Genie2000 Efficiency Calibration Curves window will be displayed.

3.3.8 This window shows a plot of the efficiency calibration curve, and the coefficients of the efficiency vs. energy function. Options are provided to change the order of the polynomial function, list the efficiency values computed for specific energies, and generate a printed plot of the displayed curve. To accept the efficiency results displayed in this window, click on **OK**.

3.3.9 At this point, the message "Processing... Please Wait" will be displayed very briefly, followed by an exit from the ISOCS software. A new efficiency calibration file will now be available for sample count analyses within PROcount. The file will be stored with the .**CAL** extension.

3.3.10 At this point the system is setup for routine in situ measurements and correct setup will be verified & validated by using both point sources and line sources per the QAPjP, (D903-003) and the ISOCS Verification and Validation Measurement Document, (D903-001).

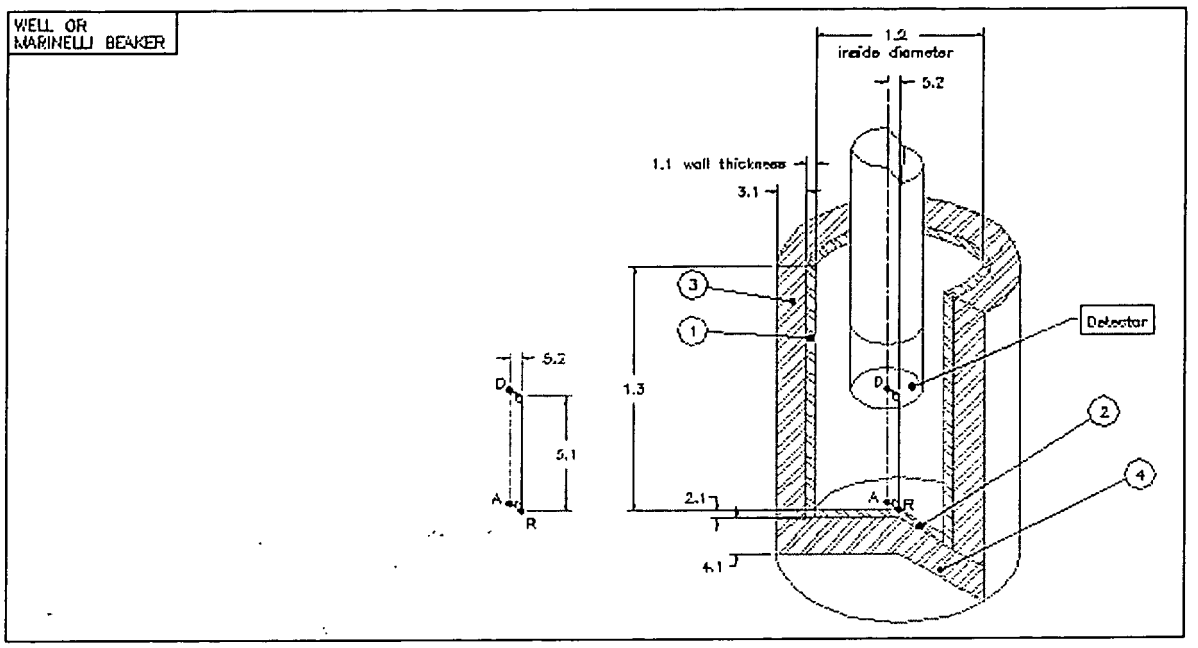
4.0 REFERENCES

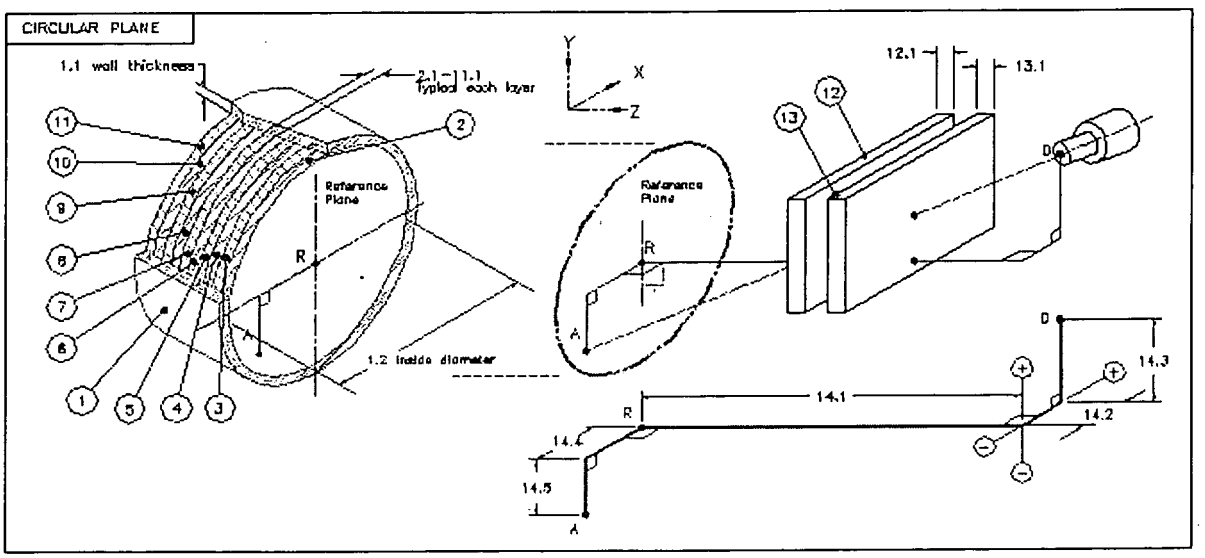
4.1 S404 InSpector Portable Spectroscopy System User's Manual, S404-USR V2.4 2/97, Canberra Industries.

4.2 S473 ISOCS Calibration Software User's Manual, S473-USR, V1.2b 12/97, Canberra Industries.

APPENDIX A

SCHEMATIC OF THE ISOCS SYSTEM





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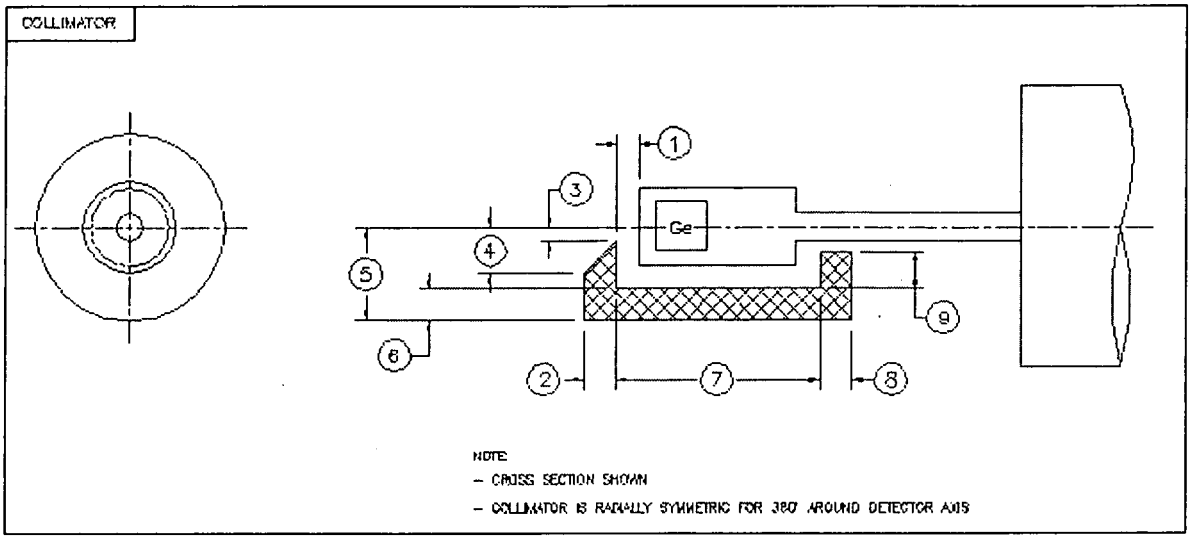

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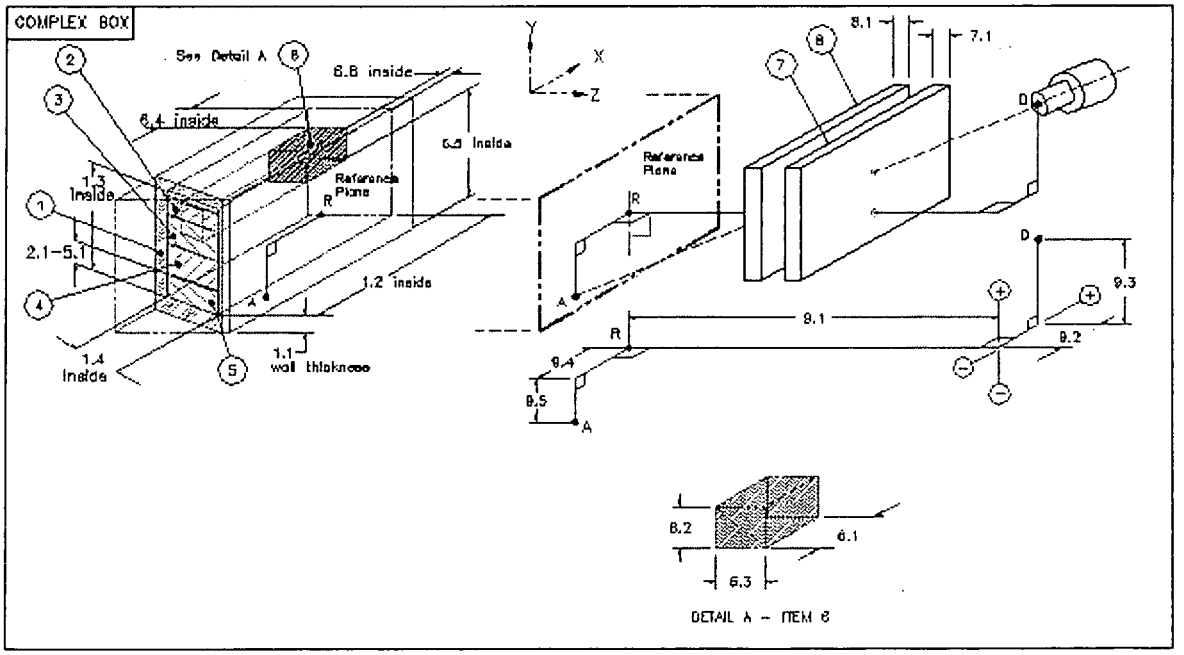

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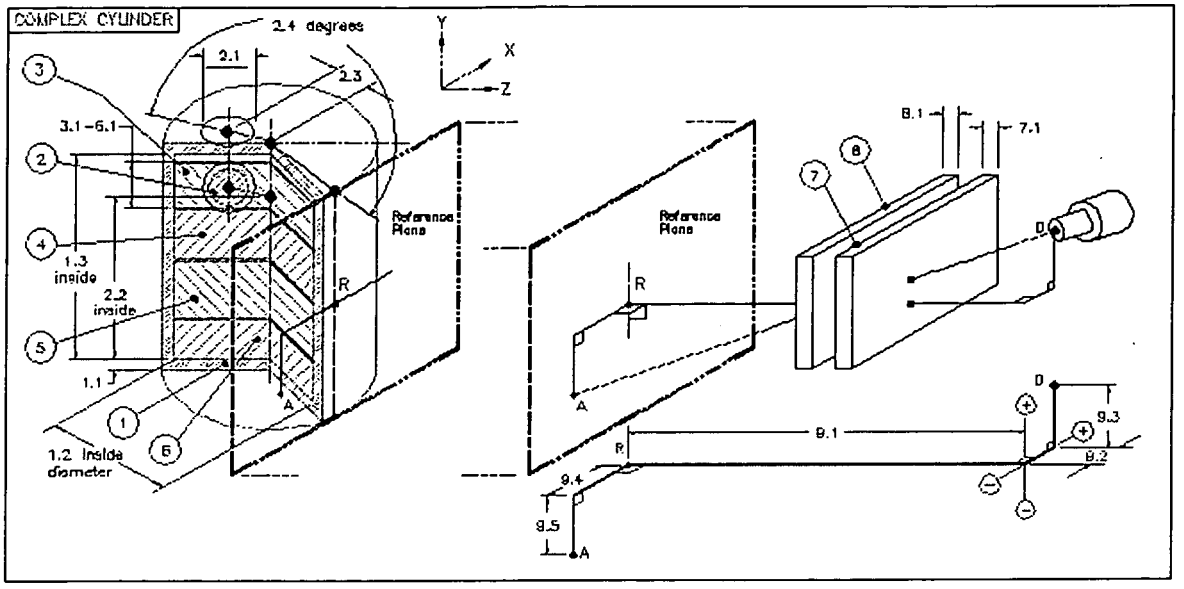

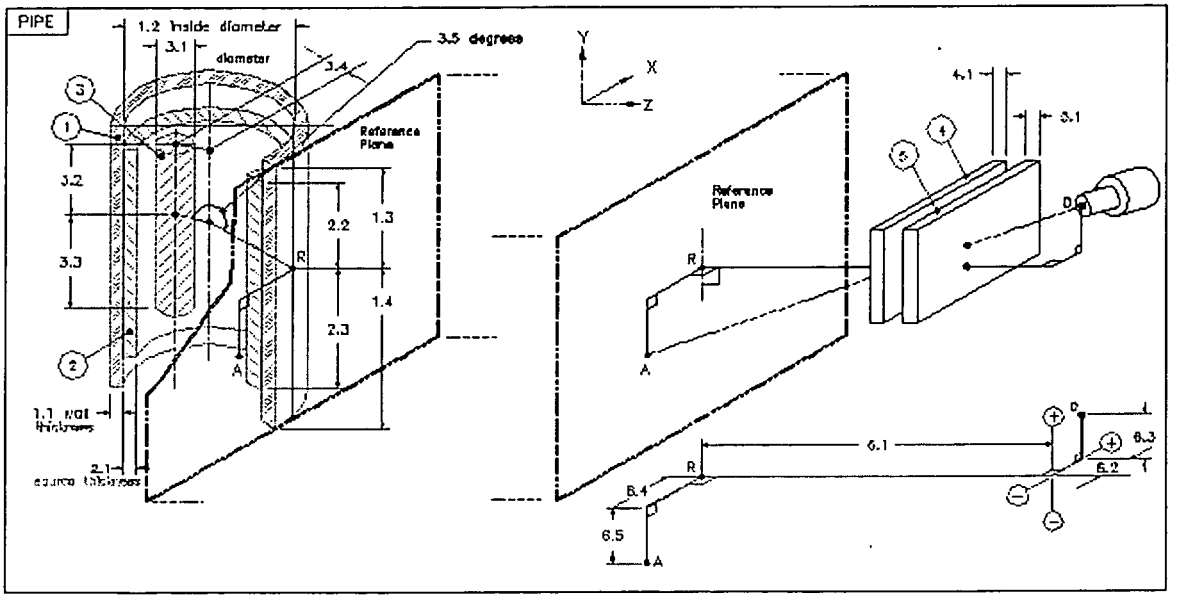

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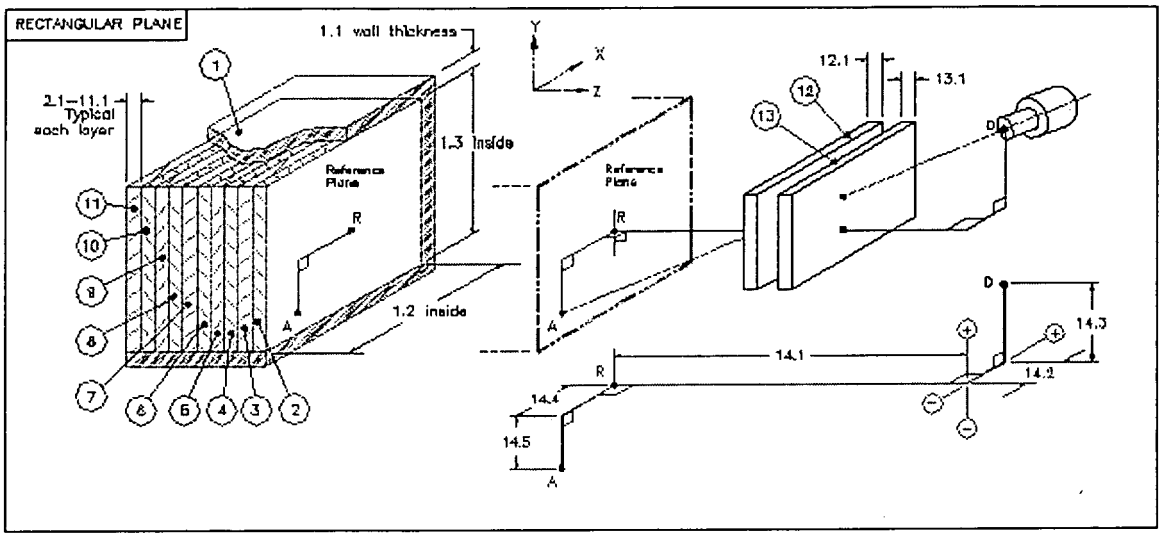

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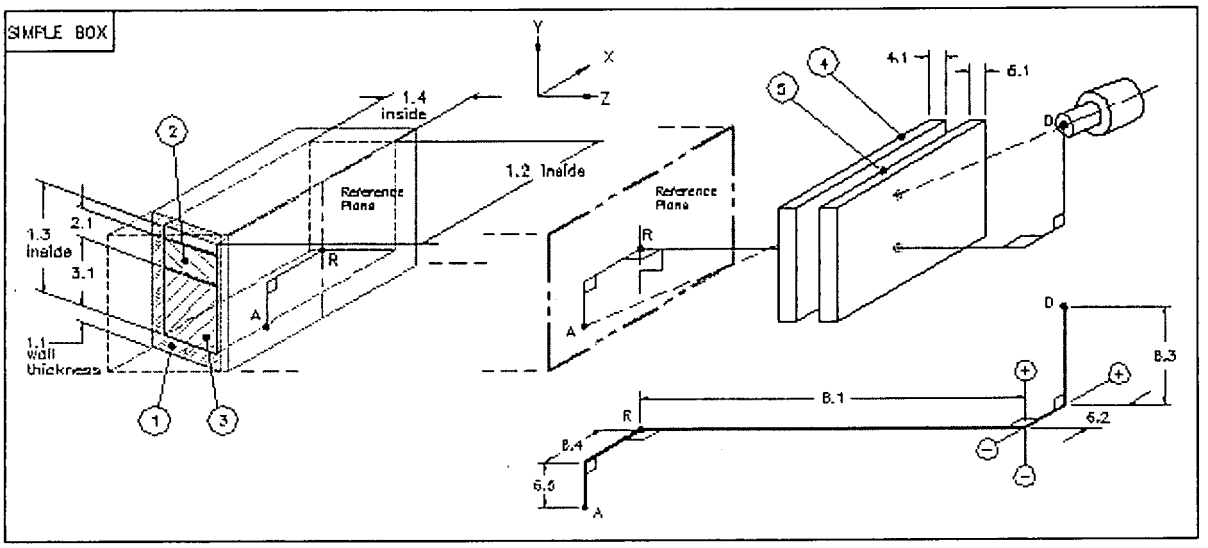

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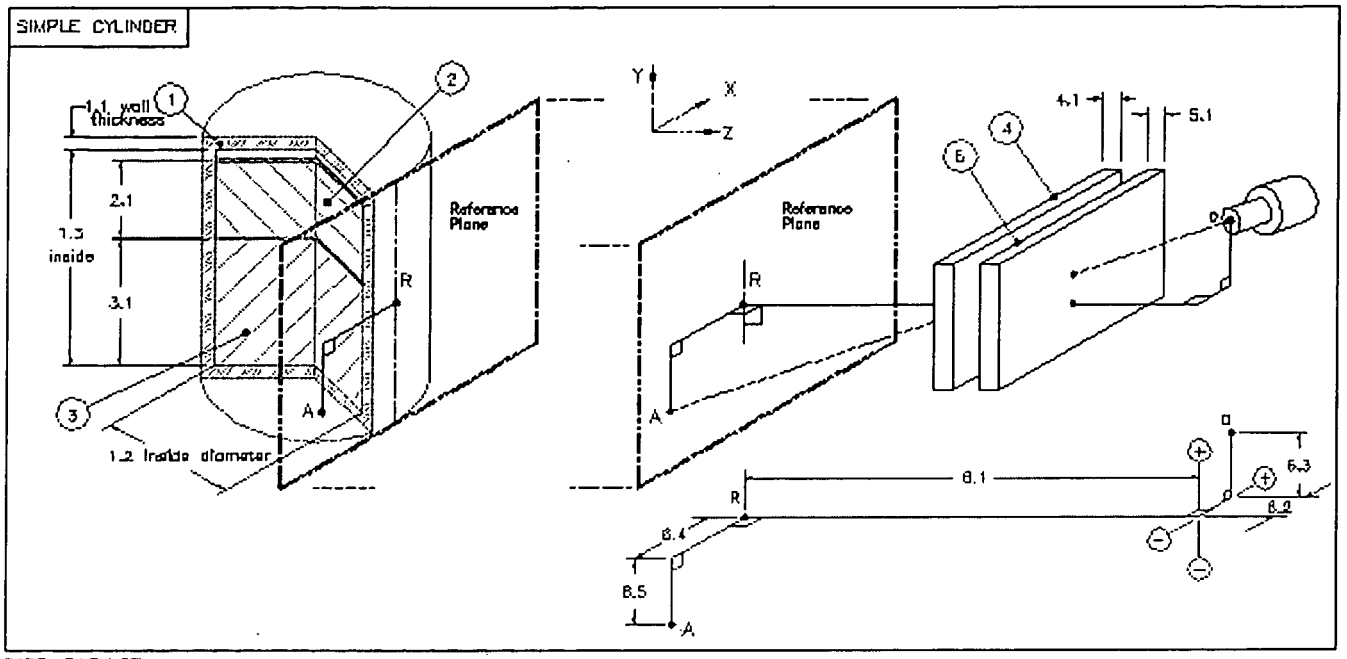

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